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NEW METHODS OF TESTING ANTIFRICTION ALLOYS

At the Institute of Machine Studies, Academy of Sciences USSR, Prof M. M. Khrushchov defended a dissertation for the degree of Doctor of Technical Sciences, which was devoted to a new method of testing antifriction alloys. This work has direct bearing on the solution of the very essential problem of friction and wear of metals and bearings. The development of many modern high-speed motors is limited to a considerable degree by the inadequate reliability of the friction components. The investigation of new, more reliable antifriction alloys and, likewise, of alloy substitutes, is possible on the basis of a system developed for their special testing.

For the first time, as the result of many years of experiments by Khrushchov and his associates, the problem of testing antifriction metals and alloys has been placed on a scientific basis. The entire work of the author answers the requirements of Soviet machine building, which is in need of antifriction alloys with a low tin content or without tin to replace the babbitt with high-tin content in automobile and tractor bearings. The solution of this question required the working out of the whole complex of questions on the evaluation of the properties of antifriction alloys and also involved development of new testing methods, as well as the designing of special testing machines.

Khrushchov's work consists of three parts. In the first part, types and methods of testing are considered with the aid of which the properties of bearing alloys can be evaluated and those properties are also analyzed which must be considered the basis for the setting up of technical conditions in regard to antifriction alloys or, in general, for their evaluation.

Khrushchov presents a new concept of antifriction properties of bearing material. Under conditions of friction with boundary lubrication, those properties of the material correspond to antifriction properties, which insure a lower temperature on the friction surface, thus protecting the boundary lubrication film from destruction, and also the property of the material to form a more stable boundary lubrication film. An antifriction effect corresponds to properties of the bearing material as a result of which rapid restoration of the boundary film is achieved in those places where it has been destroyed for some reason. This pertains, for instance, to the presence of large pores on the surface film, or in the volume of the metal, which retain the lubricant.

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In addition to this, antifriction properties also involve the property of bearing materials not to seize or to stick to the steel of the shaft after destruction in spots of the boundary lubrication layer and on unlubricated friction points, and to guarantee, for the longest possible period, a low friction coefficient (for instance, a lubricating substance of a thin film of lead on a harder foundation: lead platings, lead bronzes)

The conception of antifriction properties, as presented in Khrushchov's work, is more general and more thorough than that advanced in previously proposed theories of antifriction properties, which usually considered individual cases only

Khrushchov's work shows the effect on antifriction properties of the running-in process of the microrelief of the friction surface and of other factors. The question in regard to the effect of antifriction properties of an alloy on the operation of bearings in the region of fluid friction is examined. This effect is caused by the fact that with increased running-in of the bearing and the resulting changes in the heat conductivity and mechanical properties of the alloy, the field of possible combinations of speed and load in which fluid friction exists is widened with increased temperature. On consideration of the effect of the properties of bearing materials on the operation of bearings under various friction conditions, those general properties pertaining to service are formulated on which the evaluation depends Among these are good running-in properties and high fatigue strength

In the second part of the work, the possible methods of testing the running-in properties of antifriction alloys are investigated and, as the result of broad experimental investigations, a basic testing method is proposed involving rubbing out holes in the surface by means of a disk under graduated loads.

The process of running-in is considered as an individual case of wear and tear, characterized by a definite direction of the change of conditions on the friction surface. This means that as the path of friction is increased, the surface exposed to friction, the specific pressure, and the temperature at the points of contact (under constant local conditions such as load, speed, lubrication, etc.) are decreased.

The third part of the work deals with the question of testing antifriction alloys for fatigue, exposition of the theory of methods used, and description of the apparatus which was developed by M. M. Khrushchov for testing babbitt-alloy layers under normal and elevated temperatures. In this part, Khrushchov analyzes the internal stresses in the babbitt layer, and shows that the magnitude of the internal stresses depends not only on the form and the geometric dimensions of the bimetallic components, but also on the physical properties of the babbitt. He showed that, in the course of time, these stresses decrease because of relaxation, and that their magnitude is such that they have to be taken into consideration for the determination of the cyclic strength.

One of the main reasons limiting the use of babbitt in load-carrying bearings of modern internal-combustion transport engines is the destruction of babbitt alloy because of fatigue. An analysis of the defects of bearings led the author to conclude that the following main types of fatigue manifestations exist in babbitt: cracks in the babbitt layer occurring as a result of repeated considerable deformations of the bearing or the connecting rod, which are lined with babbitt, and cracks in the babbitt layer occurring as a result of repeated considerable pressure in the lubricated layer (under the influence of fluid friction). High internal stresses in the babbitt, high temperatures of the bearings during operation, and corrosive effects of the lubricant accelerate fatigue destruction.

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Khrushchov has developed two methods for mechanical testing of phenomenon of fatigue in antifriction alloys In one of these methods, the testing is carried out by repeated bending in one plane of flat bimetallic samples which have the form of beams of equal resistance. The test is carried out with a definite amount of bending, and continues until the appearance of cracks on the surface of the metal, which are visible under a magnifying glass. On the basis of test results, a curve is drawn showing the "logarithm of curvature of bending" plotted against "logarithm of the number of cycles up to the appearance of cracks." The tests can be carried out under different temperatures. This method is best suited for testing of antifriction alloys for the manufacture of bearings stamped from bimetallic strips The work presents examples of the application of this method

In the second fatigue-testing method, the system of the triple-roller machine, known from earlier times, is used. In this method, the test sample is a thin bimetallic steel-babbitt ring, with the babbitt layer to be tested lining the inner surface of the ring In this case, the test is carried out by repeated bending under a given stress.

In the process of fatigue testing, many new results, important for science and practice, were obtained. In particular, it was shown that the fatigue strength of a babbitt lining applied to steel depends on the thickness of the layer and increases greatly with decreasing thickness of the layer. In connection with the study of the magnitude of the internal stresses of bimetallic plates, Khrushchov was the first to notice increase of the radius of curvature in the case of bimetallic plates, an effect which continues for 3 years and which is explained by relaxation and creeping

It should be pointed out that British researchers, in experiments conducted for the same purpose, failed to discover this effect. This is a clear indication of their faulty experimental technique

The new methods of testing antifriction alloys, as developed by Khrushchov, have been put to practical use in a number of laboratories.

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